REMARKS

Pursuant to the Office Action of March 23, 2006, the Applicants are submitting on separate pages hereinbefore amendments made to the claims in the Amendment and Reply Under 37 CFR 1.111 of November 23, 2005. Applicants also gratefully acknowledge the indication that claims 1-26 and 28-38 contain allowable subject matter.

The Examiner also requested an explanation of the support in the disclosure of the original 5,974,869 patent for changes made to the claims. Therefore, for the amendment made to claim 1, in paragraph (c), Applicants clarified the "contact potential difference" as --arising from relative motion—between the component and the non-vibrating capacitance probe. Support for this can be found in the original 5,974,869 patent at, for example, col. 2, ll 42-57 including the recitation:

> The process of measuring the work function of the component comprises the creation of relative rotational motion between the component and the non-vibrating probe.

> The relationship between "work function" and "contact potential difference" can

be found at col. 2, ll 16-19. Other support is, for example, at col. 4, ll 50-64 including:

> Varying the CPD with time can be achieved by imposing a lateral displacement between the reference electrode 12 and the sample surface 14 with a heterogeneous work function. A combination of equation 6 with equation 3, which yields

> $$i = \epsilon_r \epsilon_o A(dV/dt)/d,$$

> suggests that the magnitude of the induced current decreases asymptotically with the capacitor spacing, and increases with the area of the reference electrode and the rate of CPD change.

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Regarding the further amendment in claim 1 of adding: --and changes in the contact potential difference being characteristic of correlated surface variations of the component--, please note, for example, at col. 1, ll 17-24:

> The present invention generally relates to non-contact sensors for monitoring surface variations of a component part, and more specifically relates to a non-vibrating capacitance probe which uses a variable capacitor to measure the contact potential difference between two surfaces, generally on the same component part, and thereby recognizes surface variations such as wear of an object subjected to, for example, a sliding contact.

Also, see, for example, col. 2, ll 28-31 which states:

> As the shaft rotates, the reference electrode senses changing contact potential difference with the shaft surface, owing to compositional variation.

Claim 2 included only a change of form and not substance by removal of the article "a" before -- means --.

Claim 5 was amended to focus on the feature of a "device" for relative scanning between the probe and the component. Support for this includes col. 2, ll 42-45 as one example of such a feature:

> The component is supported by roller bearings on both ends of the shaft, allowing rotation of the shaft along its axis. The shaft is rotated by a motor and the rotational speed of the shaft is monitored.

Claim 8 has additional language similar to claim 1 discussed above about contact potential difference from relative motion; and support for this can be found, for example, at col. 1, ll 17-24 and col. 2, ll 28-31.

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Claim 11 was amended to be a "non-vibrating sensor"; and support for this can be found, for example, at col. 2, ll 10, 11, 13, 15 and 19. The feature of "temporal variation of a" contact potential difference can be found, for example, at col. 4, ll 46-50:

> Instead of the variable capacitance, the current is induced by the temporal change in CPD. Therefore, in reference to equation 1, the formulation for the induced current is simplified to:

$$i = C(dV/dt)$$

Claim 12 has been amended to recite a non-vibrating sensor "which is structurally moved relative to the sample". Support for this can be found, for example, at col. 2, ll 14-17:

> The relative motion between the component and the non-vibrating probe, the distance between them, and the contact potential difference between them, all are monitored.

A further example is at col. 2, ll 28-31 and ll 42-45.

Claim 13 includes the addition of "non-vibrating" at several locations and support can be found, for example, at col. 2, ll 10, 11, 13, 15 and 19. The feature in paragraph (a) of claim 13 the "non-vibrating sensor scanned relative to the component" is supported, for example, at col. 2, ll 14-17 and 52-57 as stated before. The features in paragraph (b) of claim 13 "the temporal variations in a property selected from the group of a correlated change in surface composition, correlated change in the tribological wear of the component and correlated spatial variations of the component" are supported as follows: 1) "correlated change in surface composition" at, for example, col. 2, ll 28-31:

> As the shaft rotates, the reference electrode senses changing contact potential difference with the shaft surface, owing to compositional variation.

Also, see col. 5, ll 1-8:

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... geometry depicted in FIG. 2, along the circumference of the
cylinder 30, part of the surface 20 consists of material A, and
the rest of the surface 20 consists of material B; each material
having a unique work function.

As the cylinder 30 rotates at a constant speed, the reference
electrode 40 senses a contact potential difference with material
A, CPD_{EA}, and another potential with material B, CPD_{EB}. Also
assume that CPD_{EB} is zero.

and also at ll 27-34:

FIG. 3 shows plots of equation 9 for x values of 0.013 and 0.3.
For these calculations, V'=1, f=15 Hz, and n=1 to 10. Each
cycle of the wave consists of two major peaks, one with
positive, maximum, value, and the other with negative,
minimum, value. These peaks define the boundaries of
material A where there are sharp changes in the CPD. The gap
between the peaks widens as the length fraction of A increases.

Further, see col. 6 ll 27-39:

FIG. 7a shows an example of signal output for the silver strip
170 with a length reaction of 0.013. The signal exhibits a
series of large waves, separated by fluctuations with smaller
amplitudes. This pattern is identical to that of the theoretical
signal which is calculated for a similar length fraction, shown
in FIG. 3a. The time interval between the large waves
corresponds to the rotational frequency of the shaft 100. The
interval between the maximum and minimum peaks of each
wave packet represents the traverse of the probe 150 along the
arc length of the silver strip 170. As per FIG. 2, upon entry
into the silver strip 170, the reference electrode 152 senses an
abrupt shift in the contact potential difference from aluminum
to silver.

Regarding support for item 2) of claim 13 paragraph (b), "correlated change in the tribological
wear of the component", see, for example, col. 1, ll 20-24 and ll 38-54:

... to measure the contact potential difference between two
surfaces, generally on the same component part, and thereby

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recognizes surface variations such as wear of an object
subjected to, for example, a sliding contact.

Also, see col. 1, ll 66-67 and continuing on to col. 2, ll 1-7:

> Briefly described, in a preferred form, the present invention
> monitors the surface variations, such as surface wear, of a
> component. The surface wear is measured by the spatial
> variation in the work function of the component. The work
> function refers to an energy barrier to prevent the escape of
> electrons from the surface of the component. The invention
> detects the surface charge of the surface of the component
> through temporal variation in the work function of the
> component.

Also see col. 3, ll 1-4 wherein the object of the invention includes use as a non-contact sensor for
tribological wear.

Regarding support for item 3) of claim 13, "correlated spatial variation of the
component", see, for example, col. 1, ll 22-24:

> ... thereby recognizes surface variations such as wear of an
> object subjected to, for example, a sliding contact.

Also see col. 1, ll 66 and 67 continuing to col. 2, ll 1-7:

> Briefly described, in a preferred form, the present invention
> monitors the surface variations, such as surface wear, of a
> component. The surface wear is measured by the spatial
> variation in the work function of the component. The work
> function refers to an energy barrier to prevent the escape of
> electrons from the surface of the component. The invention
> detects the surface charge of the surface of the component
> through temporal variation in the work function of the
> component.

And also see col. 2, ll 58-67 and col. 5, ll 27-34 and the related FIGS. 3(a) and 3(b) which
identify spatial locations of materials A and B spaced along a cylinder 30.

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Claim 16 includes the addition of a paragraph (b), "<u>a system for scanning the probe relative to the component</u>"; and this has been discussed hereinbefore with support, for example, at col. 2, ll 14-17 and 42-57 and FIG. 6. For paragraph (c) of claim 16 these features added were also described hereinbefore for claim 13 (regarding composition change, spatial variation and wear); and support can be found as noted for that discussion at, for example, col. 2, ll 28-31; col. 5 ll 1-8 and 27-34; col. 6, ll 27-39; col. 1 ll 20-24 and 38-54, ll 66-67 and col. 2, ll 1-7.

Claim 22 includes the addition of the following features in paragraph (c):

> , the measured current arising from a temporal change in the
> contact potential difference between the reference electrode and
> the sample with the temporal change associated with a change
> of at least one of a compositional change of the sample,
> tribological wear of the sample and a change of distance
> between the reference electrode and the sample.

Support for these features can be found, for example, in part at col. 2, ll 17-20:

> The work function of the component is found by monitoring
> the current induced by contact potential difference in the non-
> vibrating probe and relating it to the known work function of
> the electrode in the probe.

and also further at col. 3, ll 1-4:

> Accordingly, it is a primary object of the present invention to
> provide an apparatus comprising a non-vibrating capacitance
> probe which can be used as a non-contact sensor for
> tribological wear.

and also further at col. 7, ll 38-44:

> FIG. 10 shows that, at a consistent d, the magnitude of the
> maximum peak increases linearly with the rotational frequency
> and the slope for each line increases with decreasing spacing
> distance.

and further at col. 7, ll 47-51:

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> The magnitude of the induced current which indicates the
> sensitivity of the probe, decreases asymptotically with distance
> between the probe and sample, and increases linearly with the
> rate of CPD change. These results are consistent with the
> theoretical model.

and also at col. 6, ll 59-61:

> FIG. 8 shows that the magnitude of the maximum peak
> declines non-linearly from 2.8 to 0.9 V with probe distance.

Claim 26 includes the addition of: "scanning the non-vibrating sensor relative to the sample" and support for this is, for example, at col. 2, ll 14-16:

> The relative motion between the component and the non-
> vibrating probe, the distance between them, and the contact
> potential difference between them, all are monitored.

and, for example, further at col. 2, ll 52-57:

> The process of measuring the work function of the component
> comprises the creation of relative rotational motion between
> the component and the non-vibrating capacitance probe. The
> relative motion of the component and probe, and the distance
> between the component and probe also are monitored.

Claim 28 also includes the feature added in claim 26 of "scanning the non-vibrating sensor relative to the sample" and support as recited above at, for example, col. 2, ll 52-57.

Claim 29 is a new claim which describes *inter alia,* "a sensor having a work function, the sensor diagnosed in proximity to the component at a selected distance from the component and the component having a component work function". Support, for example, can be found at col. 2, ll 1-20 and col. 4, ll 38-50. Claim 29 further includes "a mechanism to drive at least one of the components and the sensor laterally relative to one another". Support for this includes, for example, at col. 2, ll 38-57; col. 4 ll 53-67 continuing to col. 5, ll 1-67.

Further in claim 29 is recited a measurement device for measuring temporal variation in contact potential difference which can be related to different properties of the surface of the component. FIGS. 2(a), 2(b) and 3 illustrate examples of detecting a contact potential difference signal as a function of time and is discussed, for example, at col. 4, ll 65-67 continuing on to col. 5, ll 1-47; and col. 6, ll 1-65. Various properties measured are indicated, for example, at col. 1, ll 15-24, and ll 43-49; col. 2, ll 1-67; col. 5, ll 1-34; and col. 6, ll 1-64.

Claim 30 is directed to determining differences of contact potential difference at locations along a surface. Support for this can be found, for example, at col. 2, ll 25-31; col. 5, ll 1-34 and col. 6, ll 27-64. The claim includes also a non-vibrating sensor with a sensor work function; and when the sensor is disposed near a component, a surface charge is detected due to time changes of the work function of the component. Support for these features can also be found at the above cited locations and also at col. 2, ll 14-20. The last paragraph of claim 30 concerns a measurement system and is similar to that recited for claim 29 with support, for example, at FIGS. 2(a), 2(b) and 3 and at col. 4, ll 65-67 continuing on to col. 5, ll 1-47; and col. 6, ll 1-65.

Claim 31 is dependent on claim 30 and further adding the features of changes in contact potential difference which comprise characteristic measures of microstructural variations of the component surface. Support for this feature can be found, for example, at col. 1, ll 20-24; col. 2, ll 38-67; col. 5, ll 1-34; and col. 6, ll 27-54.

Claim 32 is dependent on claim 31 and concerns measuring a quantitative analysis result for the component surface. Support for this includes, for example, compositional measurements (see col. 5, ll 1-34 and col. 6, ll 6-46) which determine change from one type of material to another type of material (pure Al to pure Ag), boundary line locations are measured (see col. 5, ll 1-39), width of material (col. 6, ll 27-46), microstructural variations (col. 6, ll 47-53) and probe distance measurements (col. 6, ll 54-64 and col. 7, ll 38-41).

Claim 33 includes a sensor having a work function and disposed near a component such that when scanned relative to the component a temporal change of work function is required

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when passing from one material area to another. Support for this can, for example, be found at col. 1, ll 66 and 67, continuing on to col. 2, ll 1-7; col. 4, ll 53-56; col. 5, ll 5-34 and col. 6, ll 1-53.

Further in claim 33 is included a system to analyze the temporal change of work function to characterize composition and/or quantitative measures of dimensional changes at the surface of the component. Support can be found, for example, at col. 2, ll 22-57; col. 5, ll 1-47; col. 6, ll 27-64. Also see FIGS. 3(a), 3(b), 4 and 6.

Claim 34 is a method claim with various features including, positioning a sensor near a component surface with the sensor having a work function and the component having a work function. Support for this is, for example, at col. 1, ll 17-24; col. 2, ll 1-7 and ll 17-20. Claim 34 also includes scanning the sensor laterally relative to the component with the scanning step generating a surface charge with the temporal charge of work function. Support for this is, for example, provided at col. 2, ll 25-37 and also see FIGS. 3(a), 3(b), 4 and 5. Further, in claim 34 is the step of measuring surface charge over the component line and characterizing composition and/or wear of the component surface. Support can be found, for example, at col. 2, ll 22-31 and col. 1, ll 66 and 67 continuing to col. 2, ll 1-7. Also see col. 5, ll 1-34 and FIGS. 2(a), 2(b), 3(a), 3(b), 7(a) and 7(b).

Claim 35 is another method claim for monitoring surface variations of a component including positioning a non-vibrating probe near a component. Support for this feature can be found, for example, at col. 2, ll 8-20. Claim 35 further includes the steps of scanning the probe relative to the component, and support for this can be found, for example, at col. 2, ll 14-57 and see FIG. 5. Claim 35 also includes measuring along a line the contact potential difference with measurements characteristic of correlated surface variations of the component. Support can be found, for example, at col. 2, ll 25-31; col. 5, ll 1-34, ll 62-67; also at col. 6, ll 1-64; and at col. 7, ll 38-51. Also see FIGS. 3(a), 3(b) and 7(b)-10.

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Claim 36 is dependent on claim 35 and concerns spatially scanning of the probe relative to the component; and support for this feature can be found, for example, at col. 5, ll 62-67 and col. 6, ll 1-46. And also see FIG. 5 showing the xyz positioning system 160 and also cited stepper motors to control motion of the probe 150 along the longitudinal axes of the shaft 100.

Claim 37 is another method claim for monitoring surface variations on a component including the step (a) of determining a contact potential difference for a component by imparting relative lateral motion. Support for this can be found, for example, at col. 2, ll 52-57 and the relationship between "work function" and "contact potential difference" is described at col. 2, ll 15-20. Step (b) of claim 37 concerns monitoring the relative lateral motion between the component and the probe to identify location along the component. Support for this feature is, for example, at col. 5, ll 27-34, ll 62-67, continuing on to col. 6, ll 1-14 and ll 27-46. Step (c) of claim 37 includes monitoring the contact potential difference between the component and the capacitance probe with changes in the potential difference characteristic of surface variations in the component which can be correlated to the component location. Support for this feature can be found, for example, at col. 1, ll 20-24; col. 2, ll 1-7; and col. 5, ll 1-34, ll 62-67 and at col. 6, ll 1-46.

Claim 38 is dependent on claim 37 with the relative lateral motion mapping a line of points on the component characteristic of the correlated surface variations of the component. Support for this is provided, for example, at col. 4, ll 65-67 continuing to col. 5, ll 1-34, ll 62-67 and continuing to col. 6, ll 1-53.

In providing these descriptions of support for the features of the claims, substantial examples have been cited, but these are not to be taken as all the examples supporting the features. Consequently, these statements of support are non-limiting to the scope of the claims, particularly for these claims which have not been amended or features not argued over the prior art. In view of the above examples it is believed ample support has been provided and claims 1-26 and 28-38 are in condition for allowance, and the Applicants respectfully request a Notice of Allowance.

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Also enclosed is a Supplemental Declaration by the inventors in accordance with the request of the Examiner.

The Commissioner is hereby authorized to charge any additional fees which may be required regarding this application under 37 C.F.R. §§ 1.16-1.17, or credit any overpayment, to Deposit Account No. 06-1450. Should no proper payment be enclosed herewith, as by a check or credit card payment form being in the wrong amount, unsigned, post-dated, otherwise improper or informal or even entirely missing, the Commissioner is authorized to charge the unpaid amount to Deposit Account No. 06-1450. If any extensions of time are needed for timely acceptance of papers submitted herewith, Applicant hereby petitions for such extension under 37 C.F.R. §1.136 and authorizes payment of any such extensions fees to Deposit Account No. 06-1450.

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Respectfully submitted,

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